

**Huge Dinosaurs Battled to the Death** in prehistoric swamps. The meat-eating *Allosaurus*, right, preyed on the huge, plant-eating *Brontosaurus*, left, millions of years before man appeared.

## PREHISTORIC ANIMAL

ERAS	PALEOZOIC						
	Began 600,000,000 years ago			375,000,000 years long			
PERIODS	CAMBRIAN	ORDOVICIAN	SILURIAN	DEVONIAN	MISSISSIPPIAN	PENNSYLVANIAN	PERMIAN
	Began 600,000,000 years ago 120,000,000 years long	Began 480,000,000 years ago 45,000,000 years long	Began 435,000,000 years ago 30,000,000 years long	Began 405,000,000 years ago 60,000,000 years long	Began 345,000,000 years ago 35,000,000 years long	Began 310,000,000 years ago 35,000,000 years long	Began 275,000,000 years ago 50,000,000 years long

### EPOCHS

660



Invertebrates



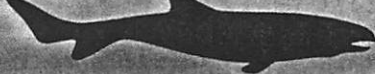
Reptiles



Amphibians



Fishes



## PREHISTORIC ANIMAL

**PREHISTORIC ANIMAL** is any animal that lived before man learned to write, about 5,000 years ago. Prehistoric animals ranged in size from tiny, one-celled animals called protozoans to huge, awkward dinosaurs. Some prehistoric animals looked much like the animals of today. Others were unlike any animals now alive. All prehistoric animals did not live at the same time. Scientists who study prehistoric animals are called paleontologists. They learn about ancient animals from fossils. Fossils are shells, bones, and other traces of animals and plants buried in rocks. Fossils of prehistoric animals tell scientists where the animals lived and what they were like. Scientists believe animals have lived on earth more than 600 million years.

### Animals Through the Ages

The farther back we go in time, the dimmer the record of fossils becomes. It quickly fades about 600 million years ago, at the beginning of what geologists call the Cambrian Period. Paleontologists know that life existed 3,100,000,000 years ago. But fossils found in rocks formed before the Cambrian Period are mostly algae (simple plants) and bacteria. See ALGAE.

The fossil record shows that animals changed slowly through the ages. The record has many gaps, but scientists can set up series of related animals showing the way they developed. The evidence from fossils supports the theory of evolution. This theory states that animals and plants changed through time, and that living things are the much-changed descendants of ancestors that lived long ago. See EVOLUTION.

**The Earliest Animals.** The oldest known fossils of animals were formed by invertebrates, or animals without backbones. Some of these animals resembled jellyfish, sponges, snails, clams, worms, and other invertebrates that live today. The prehistoric invertebrates lived in the ocean waters. They left fossils in rocks

formed in the Cambrian Period. The most common animals of this period were flat shellfish called trilobites (see TRILOBITE). They were the first arthropods, animals with jointed legs, to become common.

**Animals with Backbones** are called vertebrates (see VERTEBRATE). They probably first appeared about 450 million years ago. The oldest forms were small armored fish called ostracoderms (shell-skinned). They lacked jaws and in this way resembled modern lampreys. Their mouths were only small holes or slits that could not open wide. The early fish swam in the water and fed on soft decaying material or on tiny plants and animals. They breathed through gills, as do present-day fish (see GILL).

Gradually, fish developed jaws. By the Devonian Period, which began about 405 million years ago, fish with jaws were fairly numerous. They had a great advantage over their jawless ancestors. They could bite and eat other animals. Many Devonian fish developed

### — INTERESTING FACTS ABOUT PREHISTORIC ANIMALS —

**Dinosaur Eggs** were first discovered in Mongolia in 1923 by scientists of the American Museum of Natural History.

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**Earliest Known Horse, Hyracotherium**, was about the size of a small dog. It is also called Eohippus.

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**Largest Flying Reptile**, the Texas pterosaur, had a wingspread of about 51 feet (15.5 meters).

**Longest Neck** of any animal was that of the dinosaur *Brachiosaurus*. This animal's neck had 13 bones, and measured 28 feet 8 inches (8.7 meters) long.

**Oldest Known Egg**, laid about 270 million years ago, is that of a primitive mammal-like reptile.

**Smallest Dinosaur, Compsognathus**, was about the size of a chicken. Its skull was 3 inches (8 centimeters) long.

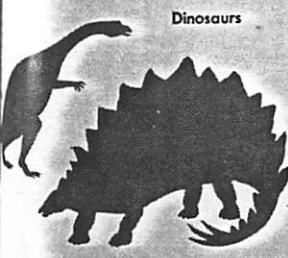
Samuel Paul Welles, the contributor of this article, is Research Associate at the University of California's Museum of Paleontology in Berkeley and coauthor of *From Bones to Bodies*.

## MESOZOIC

Began 225,000,000 years ago

160,000,000 years long

TRIASSIC	JURASSIC	CRETACEOUS
Began 230,000,000 years ago	Began 180,000,000 years ago	Began 130,000,000 years ago
60,000,000 years long	50,000,000 years long	65,000,000 years long



## CENOZOIC

Began 65,000,000 years ago

65,000,000 years long

TERTIARY		QUATERNARY				
Began 65,000,000 years ago	Began 63,250,000 years long	Began 1,750,000 years ago	Began 1,750,000 years long	Began 1,750,000 years ago	Began 1,750,000 years long	Began 10-25,000 years ago
PALEOCENE	EOCENE	OLIGOCENE	MIOCENE	PLIOCENE	PLEISTOCENE	HOLOCENE
Began 65,000,000 years ago	Began 55,000,000 years ago	Began 40,000,000 years ago	Began 26,000,000 years ago	Began 14,000,000 years ago	Began 1,750,000 years ago	Began 10-25,000 years ago
10,000,000 years long	15,000,000 years long	14,000,000 years long	12,000,000 years long	12,250,000 years long	1,750,000 years long	10-25,000 years long

Mammals



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The farther back we go in time, the dimmer the record of fossils becomes. It quickly fades about 400 million years ago, at the beginning of what geologists call the Cambrian Period. Paleontologists know that life existed 3,100,000,000 years ago. But fossils found in rocks formed before the Cambrian Period are mostly algae (simple plants) and bacteria. See ALGAE. The fossil record shows that animals changed slowly through the ages. The record has many gaps, but scientists can set up series of related animals showing the way they developed. The evidence from fossils supports the theory of evolution. This theory states that animals and plants changed through time, and that living things are the much-changed descendants of ancestors that lived long ago. See EVOLUTION.

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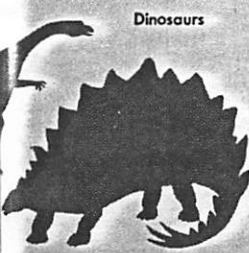
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225,000,000 years ago

0,000,000 years long

	JURASSIC	CRETACEOUS
Began	Began	Began
180,000,000 years ago	130,000,000 years ago	
50,000,000 years long	65,000,000 years long	



### CENOZOIC

Began 65,000,000 years ago

65,000,000 years long

	TERTIARY	QUATERNARY
Began	Began	Began
65,000,000 years ago	1,750,000 years ago	
63,250,000 years long	1,750,000 years long	


PALEOCENE	Eocene	OLIGOCENE	MIOCENE	PLIOCENE	PLEISTOCENE	HOLOCENE
Began	Began	Began	Began	Began	Began	Began
65,000,000 years ago	55,000,000 years ago	40,000,000 years ago	26,000,000 years ago	14,000,000 years ago	1,750,000 years ago	10-25,000 years ago
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Mammals





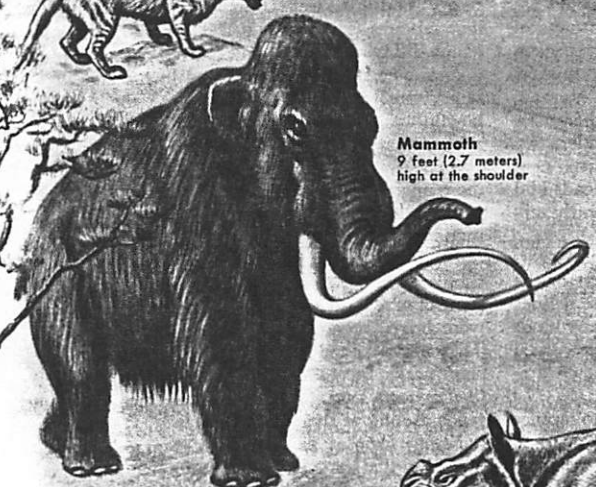
**Pteranodon**  
Wingspread 40 feet (12 meters)



**Hyacodon**  
4 feet (1.2 meters) long



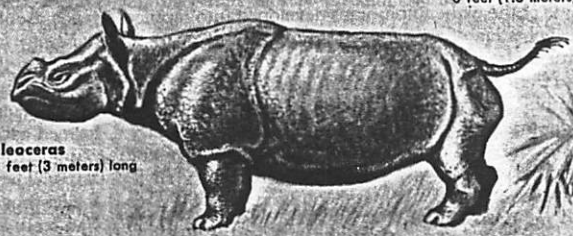
**Ichthyornis**  
8 inches (20 centimeters) long



**Mammoth**  
9 feet (2.7 meters)  
high at the shoulder



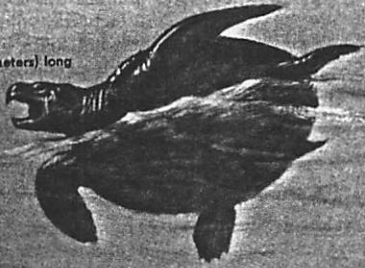
**Smilodon**  
6 feet (1.8 meters) long




**Teleoceras**  
10 feet (3 meters) long



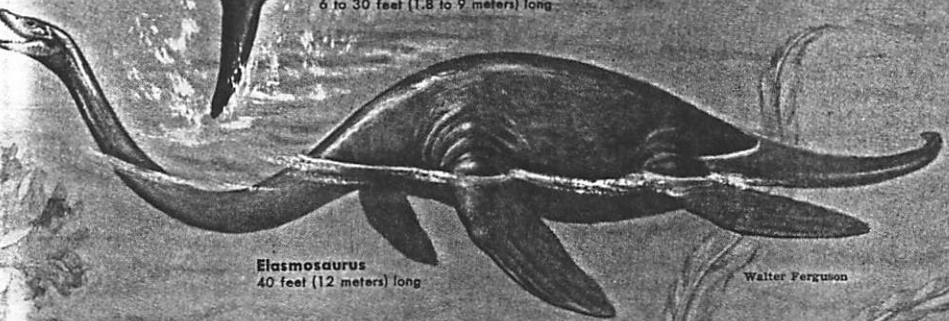
**Hyracotherium (Eohippus)**  
1 foot (30 centimeters)  
high at the shoulder



**Archelon**  
12 feet (3.7 meters) long



**Ichthyosaurus**  
6 to 30 feet (1.8 to 9 meters) long



**Elasmosaurus**  
40 feet (12 meters) long

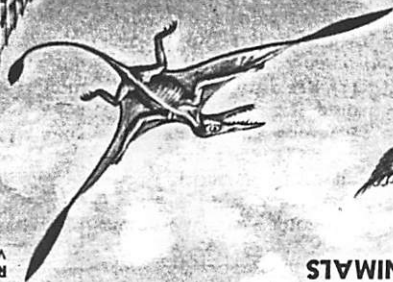
Walter Ferguson



# PREHISTORIC ANIMALS



**Archaeopteryx**  
Wingspread 2 feet (61 centimeters)  
1½ feet (46 centimeters) long



**Rhamphorhynchus**  
Wingspread 2 feet (61 centimeters)



**Dimetrodon**  
10 feet (3 meters) long



**Diplodocus**  
87 feet (27 meters) long



**Eryops**  
5 feet (1.5 meters) long



**Triobolite**  
2 inches (5 centimeters) long



**Ammonite**  
2 to 72 inches  
(5 to 183 centimeters) across



**Eurypterid**  
8 to 10 inches  
(20 to 25 centimeters) long



**Crossoplistegian**  
2 feet (61 centimeters) long



**Allosaurus**  
34 feet (10 meters) long

## PREHISTORIC ANIMAL

bony armor for protection. Ancestors of sharks and ray-finned fish also appeared during this period.

Some Devonian fishes had lungs as well as gills. A few fishes developed such efficient lungs that they could breathe air. These early *lungfish* closely resembled the lungfish of today (see LUNGFISH).

The ancestors of the first land animals also appeared during the Devonian Period. Certain fish with lungs, called *crossopterygians*, or *lobe-fins*, developed fins that had muscles supported by bones. These fish could use their fins as legs to move about on the bottoms of pools, or to come out on land for a short time. Scientists believe that, through time, fins with muscles and bones developed into the legs of land animals.

**The First Land Animals** were *amphibians*, the ancestors of present-day frogs, toads, and salamanders (see AMPHIBIAN). The earliest known amphibians lived near the end of the Devonian Period. They had heads and tails much like the crossopterygians. But the early amphibians had legs and feet instead of fins.

The Mississippian Period (about 345 million years ago) and the Pennsylvanian Period came next in the earth's history. Outside the United States these periods are combined as the Carboniferous Period. Many kinds of amphibians developed during this time. They lived along the shores of swamps. The largest known amphibians were about 15 feet (4.6 meters) long.

Some of the early amphibians developed into reptiles—the ancestors of modern snakes, lizards, crocodiles, and turtles (see REPTILE). The reptiles of the Pennsylvanian Period (about 310 million years ago) resembled the amphibians in many ways. But they had scaly skin that protected their bodies from drying up, so they could live in dry places. The early reptiles were the first animals to lay eggs with shells. Because of the shell, the reptiles could lay their eggs on land, and the eggs would not dry up.

New kinds of invertebrates appeared at the same time that the first land animals developed. Some of them were *arachnids* like present-day spiders and scorpions (see ARACHNID). These arachnids lived on land. Insects became widespread in the Pennsylvanian Period and reached enormous sizes. Some dragonflies had wingspreads of 2 feet (61 centimeters).

During the Permian Period (about 275 million years ago), reptiles developed until they became larger and more powerful than the amphibians, and became rulers of the land. During this period, reptiles called *therapsids* developed. These reptiles resembled mammals in some ways, and scientists believe the therapsids were ancestors of the mammals.

**The Age of Dinosaurs** began about 200 million years ago, toward the end of the Triassic Period. For about the next 135 million years, dinosaurs dominated the earth. Other animals living at the same time as dinosaurs included invertebrates, fish, amphibians, sea reptiles, flying reptiles, birds, and mammals.

*Dinosaurs* were the most spectacular land animals that ever lived. Huge plant-eating dinosaurs lived in swamps and along seashores. The largest of these great reptiles, *Brachiosaurus*, weighed as much as 85 short tons (77 metric tons) and grew about 70 feet (21 meters) long. Tender plants provided the huge amount

of food needed by the plant-eating dinosaurs. Their worst enemies were large *carnivorans*, or flesh-eating, dinosaurs. *Duck-billed* dinosaurs with wide mouths and webbed feet lived near the water. *Stegosaurus* were protected by armored plates. *Ankylosaurus* had heavy armor that made them look like living tanks. *Ceratopsians* had up to five horns on their heads. For a more complete description of the dinosaurs, see DINOSAUR.

*Invertebrates* lived mainly in the oceans. They included protozoans, jellyfish, corals, sponges, worms, snails, and clams. *Ammonites*, or shellfish related to the pearly nautilus, were the most common Mesozoic invertebrates (see NAUTILUS). They had coiled shells. Many different kinds of insects lived on the land.

*Fish*. The most common fishes in the Age of Dinosaurs were *ray-finned* fish, related to the present-day bowfin and gar (see BOWFIN; GAR). Modern bony fish appeared at the end of the Mesozoic Era.

*Amphibians*. At the end of the Triassic Period, the more ancient and larger types of amphibians died out. But smaller amphibians, such as frogs, toads, and salamanders, continued into modern times.

*Sea Reptiles* were of several kinds. *Ichthyosaurs* had fishlike bodies. *Mosasaurus* were gigantic marine lizards, some of which grew 40 feet (12 meters) long. *Plisiosaurs* were huge, broad sea serpents with paddlelike legs. They also reached lengths of about 40 feet. Some had short necks, but their skulls measured as much as 9 feet (2.7 meters) long. Others had short heads, but necks twice as long as their bodies.

*Flying Reptiles*, called *pterosaurs* or *pterodactyls*, appeared in the Jurassic Period. Some had wingspreads of up to 51 feet (15.5 meters). Others were no larger than robins. Pterosaurs had no feathers. A thin web of skin formed each wing.

*Birds* appeared at about the same time as the pterosaurs. They looked like small dinosaurs, but their fossils show clear impressions of feathers. These birds had teeth and long tails. See ARCHAEOPTERYX.

*Mammals* lived late in the Mesozoic Era. Scientists know little about the early mammals. They have discovered only a few fossil skulls and jaws of these animals. But they have found thousands of teeth. Most Mesozoic mammals were tiny animals, no bigger than rats, with furry bodies and pointed snouts. The largest grew as big as woodchucks. They were warm-blooded.

**The Age of Mammals**, or the Cenozoic Era, began at the end of the Mesozoic Era, about 65 million years ago. It continues to the present day. The surface of the earth changed greatly toward the end of the Mesozoic. Mountain ranges rose, and the climate became colder and drier. Shallow oceans and great swamplands dried up. Mammals could adjust to these conditions. But most reptiles could not, and many kinds died out.

The rise of the mountains created new living places. During the Cenozoic Era, many types of mammals developed from the early, small, primitive kinds.

Some plant-eating mammals of the early Cenozoic Era grew almost as large as elephants. The *untatheres* were clumsy creatures with heavy legs and small brains. They had three pairs of bony projections along the tops of their skulls. Early flesh-eating mammals called *creodonts* had long bodies and short legs.

The small ancestors of many modern mammals, including horses, camels, and *carnivores* (flesh eaters),

lived in the early Cenozoic Era. The first horse, *Hyracotherium* (also called *Eohippus*, or *dawn horse*), had four toes on its front feet and three toes on its hind feet. It was about the size of a fox. The first camel, *Protylopus*, was about the same size as *Eohippus*. *Miacis*, a carnivore about as big as a weasel, was an ancestor of such modern carnivores as the dog and cat.

In the middle of the Cenozoic Era, the carnivores began to develop into doglike and catlike animals. Some catlike animals, called *saber-toothed cats*, had a pair of long upper teeth (see **SABER-TOOTHED CAT**).

About 20 million years ago, the mountains began to wear down and large areas of grassland appeared. Long-faced giant pigs and hornless rhinoceroses roamed the plains. A three-toed horse called *Merychippus*, or *chewing horse*, appeared. It was about the size of a donkey. *Merychippus* had long teeth to grind coarse grasses. Ancestors of the deer first appeared, and mastodons entered America.

Later in the Cenozoic Era, the climate became drier and colder. Relatives of the elephant were numerous. Some of them had long lower jaws and downward-curving tusks. Others, called *shovel-tuskers*, had two flat teeth that stuck straight outward from their lower jaws and broadened into a "scoop shovel" nearly 2 feet (61 centimeters) wide. Some camels grew about 10 feet (3 meters) tall, or slightly larger than modern camels. They had long legs and long necks. Scientists believe prehistoric people began developing about 2½ million years ago (see **PREHISTORIC PEOPLE**). Mammoths and mastodons that looked like hairy elephants lived on the North American plains together with camels, llamas, and one-toed horses (see **MAMMOTH**; **MASTODON**). Other animals included giant ground sloths the size of small elephants, and *glyptodonts* with solid shells of bony armor that resembled the armadillo (see **GROUND SLOTH**). *Smilodon*, the last and largest of the saber-toothed cats, probably terrorized the slow-moving mastodons and sloths. The woolly *coelodont*, a relative of the rhinoceros, lived in the vast prairies of Europe and Asia during the Ice Age. Cave dwellers hunted the giant cave bear, an ancestor of the European brown bear, and drew pictures of it. Many kinds of mammals of the Ice Age still exist today. See **ICE AGE**.

## Determining When Prehistoric Animals Lived

Paleontologists use several methods to learn when prehistoric animals lived. Most fossils form in *sedimentary* rocks, or rocks built up in layers (see **Rock (Organic Sediments)**). The oldest fossils usually lie in the deepest layers. The order of the rock layers indicates the order in which the animals developed.

But the rock layers do not tell how long ago an animal lived. To learn this, scientists must find the age of the rocks. In one method, they study the amount of radioactive elements in the rocks (see **RADIOGEOLOGY**). The rocks containing the oldest fossils known are about 3,100,000,000 years old.

## Why Prehistoric Animals Disappeared

Animals became *extinct* (died out) chiefly because the earth changed. Their bodies and habits often could not change fast enough to keep up with the changing conditions. For example, when mountains rose up or seas drained away, the climate and conditions on the

earth changed. Animals that could not adapt themselves to the new conditions died out.

Evolutionary changes in other animals appear to have been often responsible for extinction. A plant-eating form may disappear if more efficient competitors for the same food supply have appeared. A flesh-eating animal may become extinct if the animals that it eats become fast enough to escape, or if they die out.

All the animals of one kind did not die out at once. One kind may have disappeared on one continent, but left related survivors on other continents. For example, rhinoceroses vanished from North America, but other rhinoceroses still exist in Africa and Asia. All kinds of animals did not die when conditions changed. Some animals moved to new areas with better conditions. Others adapted themselves to the changes.

## Living Fossils

Some large groups of animals have died out, leaving only a few survivors. These survivors have not changed much from their remote ancestors. Scientists call them *living fossils*. They include the king crab, a relative of the scorpion; the *coelacanth*, a kind of crossopterygian; and a lizardlike reptile called the tuatara (see **COELACANTH**; **KING CRAB**). These creatures give scientists an opportunity to study the bodies and habits of living animals that closely resemble animals of prehistoric times.

SAMUEL PAUL WELLES

Critically reviewed by ROY CHAPMAN ANDREWS and ALFRED S. ROMER

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### Outline

- I. Animals Through the Ages
  - A. The Earliest Animals
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  - D. The Age of Dinosaurs
  - E. The Age of Mammals
- II. Determining When Prehistoric Animals Lived
- III. Why Prehistoric Animals Disappeared
- IV. Living Fossils

### Questions

- Why did many prehistoric animals become extinct?
- How do we know what prehistoric animals were like?
- What kinds of reptiles lived in the Age of Dinosaurs besides the dinosaurs?
- When did birds first appear? What were they like?
- Why were the crossopterygians important to the development of the vertebrates?
- What were the earliest mammals like?
- What is a living fossil? Why are living fossils helpful to paleontologists in studying prehistoric animals?
- What were the first land animals?
- What common animal did the first vertebrate resemble?
- Why were bony plates valuable to early fish?